E.C.A. IMP. SUB. 20 SEP. 1929 ENTOM.

Vol. 2.] 1929. [No. 2.

AGRICULTURAL JOURNAL

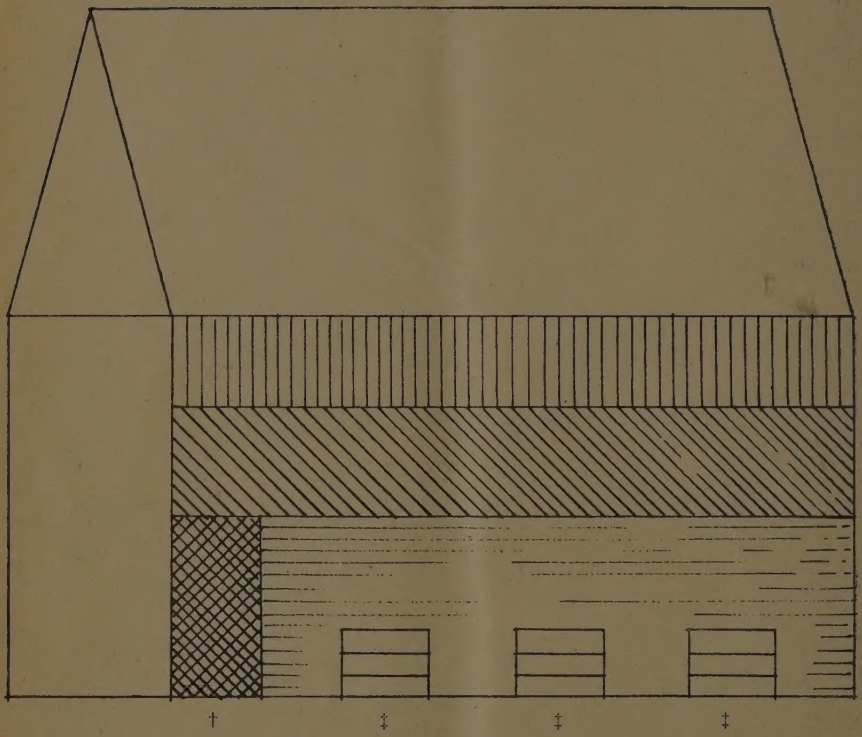
Issued by the
Department of Agriculture, Fiji.

PRICE, ONE SHILLING.

BY AUTHORITY: J. J. McHUGH, GOVERNMENT PRINTER, SUVA.
1929.

COPRA DRYING SHED.

Roof of galvanised iron or cadjain.



* Platform allowing half inch to one inch spaces between the slats.

† Opening under platform to allow of access below for laying the coconut shells and lighting the fires.

‡ Steps outside of wall to permit of copra being rapidly placed on and removed from the platform.

§ Front wall 5-6 feet high: back wall to eaves of building. The front wall sometimes is flush with the platform, but in other cases it is some six inches above the level of the platform, and if so arranged is reported to result in the prevention of some loss of heat.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 2.] SECOND QUARTER, 1929. [NO. 2.

EDITORIAL.

STAFF NOTICES.

Information has been received that Mr. A. C. Barnes, B.Sc., Assistant Director of Agriculture, Zanzibar, has been appointed as Superintendent of Agriculture, Fiji, and is expected to arrive on August 9th.

Mr. A. B. Ackland, Chief Clerk, has been appointed to act as Assistant Superintendent of Agriculture pending the arrival of the new Superintendent of Agriculture, as from June 26th.

Mr. H. W. Simmonds, Government Entomologist, to act as Mycologist during the absence of Mr. J. G. C. Campbell on leave, as from 1st June.

Mr. H. M. Stuchbery, B.V.Sc., Melb., will act as Senior Veterinary Officer during the absence of Mr. C. R. Turbet on leave.

The Coconut Entomologist, Mr. R. W. Paine, arrived in Java on June 8th where he will undertake investigations regarding the coconut spathe borer. *Tirathraba* sp.

THE DRYING OF COPRA.

By F. A. STOCKDALE, Assistant Agricultural Advisor to the Secretary of State for the Colonies.

THERE is an indication that information is required in regard to the preparation of copra. Proposals for research work in some Colonies have been considered and have been sanctioned. Mr. Sampson of Kew and the Imperial Institute have prepared memoranda on the question of copra drying, but it is thought that these memoranda can, with advantage, be supplemented by notes on the systems of copra preparation common to Ceylon.

The picking of coconuts takes place every two months in Ceylon. The method employed is either climbing the palms and cutting down the two lower bunches or, more commonly, from the ground by means of a sickle-shaped knife attached to the end of a long bamboo. On a well managed cultivation, the nuts of the two lower bunches are mature and are picked at each picking round, but, of course, judgment of maturity is essential and can only be settled by the pickers and by the supervisory staff. After harvesting, the nuts are heaped in central places in the plantation for six weeks to two months for drying, as this process facilitates the husking work

and the subsequent extraction of the kernal. Husking is done on an iron spike firmly fixed in the ground and each husked nut is then split with a large knife or cutlass into halves across the shorter axis and placed on the ground to dry, concave side upwards. The kernel as it dries separates itself from the shell and can then be removed for the manufacture of copra. This initial drying to separate the kernel from the shell is usually done in the open and is reasonably rapid in sunny weather, but there are instances in wet districts when this initial separation of kernel from shell is effected in the drying sheds by means of heat.

In the dry districts of Ceylon, where there is certainty in regard to weather conditions, the copra is prepared by drying in the sun, but in the wetter districts, and these embrace the greater part of the coconut-growing areas, sun drying is only done in the drier months of the year, and during the wet weather, or during those months when the weather is uncertain, artificial drying is resorted to.

Artificial drying is done on a few larger estates in the upper storey of a properly constructed factory heated under the flooring of the upper floor by means of hot air drawn or driven through a series of galvanised iron pipings. The principle followed is similar to that adopted in the earlier days for heated tea factories and consists of a hot-air generating plant with engine-driven fans for providing for the circulation of the hot air. Such a system has recently been installed in the Central Experimental Station of the Department of Agriculture at Peradeniya, and details of that station's factory equipment can be secured from the Director of Agriculture, Ceylon.

The most general system of artificial drying, and the one more suitable for small holdings on account of its inexpensiveness, is the system of copra kilns or drying sheds. This kiln consists generally of a small shed made with brick walls and pillars surmounted by a galvanised roof, or with mud or wattle and mud (daub) walls surmounted by a roof made of plaited halved coconut-leaves (cadjans). In this shed is fixed a platform consisting of wooden slats—often made of the split stems of the areca nut palm. This platform is placed about 5–6 feet above the floor level and on it the copra is placed for drying. The height of the platform above the ground and the fire is a matter of practical importance and varies in different districts—probably on account of slightly varying average air temperatures and on account of the often greatly varying degrees of humidity. On the mud floor of the shed dried half coconut shells are arranged in rows, the concave of the one being fitted into the convex of the other, and each row alternating thus:—

((((((((((((A. row 1.
B.)))))))))))) row 2.
&c.

These shells burn slowly and with practically no smoke and, in order to secure an even burn over the whole building, row 1 would be lighted at A. and row 2 at B., the burning thus taking place in every alternate row in opposite directions. The number of rows to be lighted and their position throughout the shed can be ascertained by experience. The half coconuts either shortly after being halved or, preferably, after they have dried in the sun for a few days, are placed on the slatted platform with the kernels still in the shells, or in good weather the kernels alone are put on the platform after having been removed from the shells. A thickness of three to four layers of such shells or kernels are placed on the platform, but it is wiser not to place them too thick. The fire of dried shells is made as described above. If kernels in the shells are placed on the platform they are

ultimately removed from the shells and drying continued until it is completed, usually with 5–6 days. Finally, the dried copra is taken to a store and sorted over into different grades, No. 1 consisting of thick, clean and full half nuts, No. 2 consisting of thin, soft, full or broken half nuts, and No. 3 consisting of thin, soft dark pieces.

The accompanying sketch may tend to illustrate such a copra shed as that above described. It is a common feature of Ceylon coconut-growing areas and produces quite a good quality copra if mature ripe nuts are alone used. If green nuts are picked either carelessly or purposely for the production of fibre from the husks a low grade copra is turned out, and this in no case should be mixed with a good quality product.

Experiments were made by the Department of Agriculture in Ceylon with the object of improving the copra drying sheds. These experiments consisted of no change in principle but simply included the provision of sliding trays instead of the fixed platform, or, alternatively, a sliding roof structure. These improvements were suggested by the design of cacao-drying houses or boucans in the West Indies, and would enable either sun drying or artificial drying to be utilised in the same building. The experimental developments were successful and good copra was produced in them, but they have not been adopted by copra producers, who are satisfied with their existing practices and types of drying houses.

THE NATURAL CONTROL OF THE COCONUT SCALE.

By T. H. C. Taylor, Entomologist, Coconut Committee.

Progress Report.

The importation into Fiji of several species of Coccinellid beetles which feed on the Coconut Scale (*Aspidiotus destructor*) has already been recorded in this Journal (Vol. I, No. 2). During 1928 the beetles were distributed to all the islands on which scale is known to occur, and it is now certain that they are well established in Fiji.

An opportunity has recently arisen of revisiting certain districts (notably Savusavu and Wainunu) in which the beetles were first liberated about a year ago. At that time the scale was doing a great deal of damage to the coconut trees in both of these districts and was spreading to such an extent that it became a serious menace to all planters. At the present time (May, 1929), the pest is no longer spreading and appears, in fact, to be almost completely exterminated even in those localities where it was so prevalent that the yield of nuts was reduced almost to nill. Moreover, all the trees already show a marked improvement in their general condition. They are rapidly losing the sickly yellow colour which is no characteristic of the ravages of this insect and are regaining their normal healthy appearance, the young leaves which have opened since the advent of the beetles being entirely free.

It is remarkable that these very satisfactory results should have been attained in so short a time. It was originally anticipated that a period of at least two years would have to elapse before any marked improvement could become apparent, and yet there is every indication that within a year a complete control has been effected. In fact, the predatory beetles imported to attack the scale promise to be as rapid in their action and quite as efficient as the parasites imported to combat *Levuana*.

On Muanicula estate on the west bank of the Wainunu River a very severe outbreak of scale occurred, particularly on a hill about 1½ miles from the mouth of the river. Mr. Mark Dods, the manager of this estate, who has taken a keen interest in the campaign and has rendered much assistance in the work, expresses the opinion that the scale is now completely suppressed at Muanicula, and the trees in the infected areas certainly promise to produce a normal crop of nuts next year. On the other side of the river (Captain Robbie's estate) scale was plentiful during 1928. A severe outbreak occurred on the coconuts on the plateau where tea is grown. The beetles have, however, spread across the river from Muanicula (without artificial aid) and are destroying it rapidly. There was also a small isolated outbreak at the mouth of the Wainunu River, on the east side, opposite Mr. Dods' house. The beetles have discovered this outbreak and are now abundant there, despite the fact that they had to spread about two miles from the place where they were originally liberated in order to reach it.

In the Savusavu district the results obtained have been even more remarkable. Probably the most severe outbreak in the Colony was that which occurred around Wailevu, on the north side of Savusavu Bay. There was a continuous belt of the disease all along the coast for a distance of about three miles on either side of Wailevu. Every tree within this belt was very severely attacked and many were killed. A colony of beetles was liberated in August, 1928, at Wailevu in the hope of effecting a control. In March, 1929 (i.e. only six months later), they were found to have spread throughout the infected area, and except at the extremities of the belt were, or had been, present on every tree. A very noticeable feature of their activities is that they destroy all the scale as they advance. For instance, all the scale has been completely destroyed for a distance of one mile from Wailevu, and the beetles are now scarce within this mile, since there is very little for them to eat. In the second mile, however, the beetles are present in hundreds on every tree and the scale is rapidly becoming less abundant. Their larvæ, which bear long white waxy tufts, are so numerous that they give the undersides of the leaves a whitish appearance, and their pupæ, which are usually massed together at the bases of the leaf-stems, form conspicuous white patches, six inches (and sometimes more) in diameter, which can easily be seen on tall trees from the ground. In the third mile scale is still plentiful and beetles are only to be found here and there. The rate of spread in this neighbourhood is not so great as elsewhere because the quantity of scale present was much greater, but the progress made is very satisfactory. By the end of 1929 there will, in all probability, be none left there.

The most striking instance of the general efficiency of the beetles as controlling factors occurred in the Savusavu district, along the coast from Savusavu to Nagigi. The scale was prevalent at intervals all along this coast and caused much damage. Two colonies of beetles were liberated in May and August, 1928, at Naidi. Within eight months they had spread of their own accord throughout the infected area which is about ten miles long, and had killed off all the pest in both directions as they advanced. In March, 1929, they were abundant at Nagigi (at the eastern end of the infected area) and at Naseva (towards the western end), though at all intermediate points they were rare, having no food left. The distance from Naidi to Nagigi is about seven miles. In many places on this coast there are considerable areas of dense bush which separate scale-infected patches of coconuts. There is little or no scale in these forest areas and the diseased belt is therefore by no means continuous. This discontinuity, however,

has in no way affected the rate of spread of the beetle, which is evidently capable of flying a considerable distance (at least a mile) in its search for food.

An excellent example of the thoroughness of the work of the beetle was found on Major Willoughby Tottenham's estate at Devadara. A small coconut palm, about ten feet high, has a little scale on one leaf only. There was none on any of the other trees within a quarter of a mile in any direction. Nevertheless, the beetles found this leaf and three adults were seen feeding on the scale on it.

Savusavu Bay is bounded on its eastern side by a long, hilly, peninsula which extends in a south-westerly direction and terminates at Savusavu Point. Naidi, where the beetles were originally liberated, is situated on the south coast of this peninsula about six miles from the point. A small outbreak of scale occurred at Daku which is on the north coast of the peninsula. The beetles discovered this outbreak within nine months of the date of their original liberation, and whether they travelled over the hills or round the point, the feat is a very remarkable one. There is no scale in the hills and the probability is that they followed the coast round the point. The distance from Naidi to Daku, via the point, is about ten miles.

The references which have been made to the distances covered by the beetles must not be interpreted as meaning the distances which single individuals are capable of flying. What is meant is that successive generations move on in search of food. The rate of multiplication is enormous, and the demand for scale therefore increases rapidly. The life-cycle from egg to adult occupies about 3½ weeks, and experiments conducted on Ovalau have shown that each female beetle lays about 120 eggs per month, provided an abundant supply of food is available. Hence, if 10 female beetles were liberated in a certain locality at the beginning of March, for instance, at least 1,200 adult beetles would be produced during April. About 600 of these will be females, and therefore about 72,000 will be produced in May, and so it goes on. It is easy to understand from this why the beetles clear up the scale so rapidly in any one locality and why it becomes necessary for them to spread so far in search of food.

Wainunu and Savusavu have been specially mentioned in this report because they have been inspected more thoroughly than other districts. Brief inspections of other localities have, however, been possible from time to time, notably on the islands of Gau, Wakaya, and Ovalau, and have been sufficient to show that equally satisfactory results can be expected on all islands where scale was formerly a severe pest.

This very satisfactory position is due almost entirely to the small Coccinellid beetle, *Cryptognatha nodiceps*, Mshl. Of the four other species imported from Trinidad at the same time, two appear to be established in Fiji but are not playing an appreciable part in the control of the disease.

Despite the success obtained to date, which has surpassed all expectations, it is still necessary to be cautious in referring to the prospects for the future. It is the object of the Coconut Committee to effect an absolutely permanent control of the scale in Fiji, and it can certainly be said that there is every prospect of this object being attained, but it is necessary to wait at least two more years before any final conclusions can be drawn.

INTRODUCTION OF NATURAL ENEMIES AGAINST THE HOUSE FLY IN FIJI.

By H. W. Simmonds, F.E.S., Government Entomologist.

In our last issue the introduction into Fiji of *Spalangia cameroni*, a parasite of house fly puparia was recorded. Approximately 10,000 of these insects have now been bred and liberated, mostly within the Suva district, but colonies have also been placed at Rewa and Tailevu.

We are again indebted to our Hawaiian colleagues for another insect to be used in our efforts to reduce the pest. This is a dung burying beetle *Copris incertus* var *prociduus* Say, a strong colony of which, numbering 623, arrived by the last mail boat. Some 615 were liberated near Suva and it is much hoped that they will establish themselves and become sufficiently numerous to, by burying and breaking up the cow droppings in the paddocks, reduce the amount of this material available in a suitable condition as a medium for fly maggots to live in.

EXPERIMENTS WITH HOUSE FLIES IN FIJI.

By H. W. Simmonds, F.E.S., Government Entomologist.

During the wet or summer season, house flies, in certain parts of Fiji, become exceedingly numerous and this has now been shown to be due to the fact that, at that season of the year, they are able to breed up in great numbers in cow droppings. With the advent of the cool season, which is generally, but not always, considerably drier, their numbers decrease to such an extent as to be almost negligable, although they still continue to oviposit freely in the droppings. It has been found, however, that the resulting maggots in most cases fail to reach maturity and marked droppings which were observed to carry a quantity of eggs, failed to show any larvæ when examined later. This mortality seems to take place in many cases, shortly after the eggs hatch and it was thought that it might be due to the lower temperature prevailing at this season, but the following experiments seem to indicate that this is not so.

Fijian Cool Season Temperature.

Fijian cool season temperatures frequently drop to about 65° F. at night with a diurnal maximum averaging about 79° F.. Occasionally at night it drops to as low as 60° F.

Temperatures of Droppings.

Efforts were made to ascertain how far fermentation raised the temperature of the droppings above that of the atmospheric shade. It was found that as a rule, this rise only took place during the first five days and was never more than 3° F. above the diurnal shade temperature.

Laboratory Experiments.

First Experiment.—A number of fly ova were collected and placed upon fresh cow dung in glass jars. These were kept at normal temperature in the office. The eggs hatched in due course and the maggots developed normally, producing adults in a minimum of 15 days, with an average of 16·55 for 140 individuals.

During this period the temperatures were: mean maximum, 79·76° F.; actual maximum, 84° F.; mean minimum, 69·11° F.; actual minimum, 65° F.

This compares with 11 days as a minimum egg to adult with an average of about 12 days obtained under similar conditions in summer, when the temperature stood at: mean maximum, 87·5° F.; actual maximum, 91° F.; mean minimum, 76·16° F.; actual minimum, 74° F.

The average being thus 7·39° lower than in summer with a lengthening of the life cycle by about 4½ days.

Second Experiment.—In the next experiment similar preparations were made, but the jars were placed in an incubator and kept at a uniform temperature of 68° F., a total variation of less than 1° being maintained. During the first five days the dung had risen to a temperature of a little less than 2° F above that of the incubator falling again by the sixth day to the 68° of the incubator and, remaining thus until the end of the experiment.

The temperature of this incubator was below the mean winter minimum of Suva, yet despite this the fly eggs hatched and the maggots went through to maturity taking 17 days for the earliest individual and an average of 26·14 for the batch of 61 specimens.

The experiment was repeated with similar results, the bulk of the individuals taking 21 to 24 or 25 days from egg to adult.

Third Experiment.—In this experiment an effort was made to test the result of lowering the temperature considerably below the Suva minimum, using an ice box. There was a good deal of variation and on two occasions the ice ran out, occasioning a rise to 65° F. Normally, however, it stood between 55° F. and 62° F. with a mean maximum of 58·4° and a mean minimum of 57·25° F.

In this case it was found that the dung temperature was proportionally higher and varied far more than in the former tests, maintaining an average of 5·8° F. above that of the ice box, or approximately 63·6 F.

At this temperature, whilst there was considerable mortality and only some 20 flies reached maturity, the life cycle being extended to 30 to 34 days.

Summary.

These experiments seem to show that the lower temperatures of the winter season are not the direct factor leading to the reduction in the numbers of this pest.

Field observations have also shown that, the prolonging of the life cycle, is not in itself the factor; as marked droppings were found to be sufficiently moist when 14 days old for the development of maggots, whilst the bulk of these disappeared long prior to this.

CONTAGIOUS OPTHALMIA IN SHEEP.

By H. M. Stuchbery, B.V.Sc.

An outbreak of contagious opthalmia has recently occurred in a flock of sheep in Fiji. This disease manifests itself as a conjunctivitis and keratitis, sometimes of one eye, but generally of both. It occurs in most domestic animals, but chiefly in ruminants, assuming epidemic proportions most frequently in sheep, doubtless on account of their gregarious habits. It is definitely contagious, but the casual agent has not been actually isolated. Pyogenic bacteria have been found in the lesions, but these organisms, when isolated, will not cause the characteristic symptoms of the

disease and their presence in the lesions is regarded as a secondary invasion. A specific organism causing periodic opthalmia in horses, has been isolated in America, but it is doubtful if the two diseases are identical.

The origin of the outbreak under review is somewhat obscure. There were two recent importations into the flock, these being two rams from Australia. At the time the flock was examined by the writer these two animals showed no signs of eye trouble or ill-health of any kind. It is quite possible that they may have recovered from the disease, and were still acting as carriers of the casual organisms, or they may even have been acting as carriers without having had the disease themselves.

In this outbreak, the first symptoms were an inflammatory condition of the conjunctiva of the upper eyelid, accompanied by lachrymation. This inflammatory process gradually spread, in a descending fashion, over the whole external surface of the eye and conjunctiva. The conjunctiva was at first slightly infected, later becoming deep red and somewhat swollen. The sclera, or white of the eye, showed increase in the number and size of the blood-vessels, with consequent reddening. The cornea, or pigmented portion of the eye, first showed a bluish-white cloudiness, which became increasingly dense until, in the majority of cases, the cornea appeared quite opaque. In many cases, ulceration of the cornea was also present. Accompanying these symptoms there was a considerable purulent discharge from the eyes, and the animals evinced signs of severe pain. In all cases, the vision was affected to a greater or less extent. Where the opacity of the cornea was complete, the animals were totally blind. When this disease is neglected blindness may be permanent, due either to complete ulceration of cornea with extraversation of the contents of the anterior chamber of the eye, or to permanent opacity of the cornea.

When attention was first drawn to this outbreak there were about fifty animals affected, with seven cases of total blindness. As the disease had been in progress some time, it seemed probable that a number of animals not yet showing symptoms were already infected.

The first step in the treatment was the separation of the affected animals from those apparently healthy. Instructions were given that a strict watch be kept over the latter for the detection of fresh cases.

A lotion of zinc sulphate 2 per cent. and boric acid 1 per cent. in water was first used for treatment of the symptoms. This gave satisfaction in the majority of cases, but some did not respond as well as was expected. For these, a solution of silver nitrate 2 per cent. in water was used and this lotion was found to give more satisfactory results. It was intended to treat the patients twice a day, but owing to the numbers, treatment could only be performed once daily, except the severe cases, where two applications were made.

As expected the disease continued to spread through the remainder of the flock, until practically every animal had contracted it. As many as twenty totally blind cases were noticed at one time. Several sheep were lost through falling into waterholes. These were the only fatalities. The writer was unable to follow the progress of the disease to the completion of the outbreak, owing to having to leave the district, but advice from the owner shows that it has now been cleared up.

As far as can be determined this is the first recorded outbreak in the Colony. It is also the most severe attack the writer has experienced, both in point of severity of symptoms and percentage of affected animals. Out-

breaks in Australia have come under our observation where the percentage of infection has been 40 to 50, but the usual would be in the vicinity of 10 per cent. The probable explanation of this is that these sheep have never before been exposed to an infection of this kind, and their resistance was consequently less than that of animals where the disease is more common. It is a recognised fact that a primary outbreak of a disease in a country new to it, is always more severe in effect, both in point of numbers attacked and symptoms manifested, than those outbreaks in which the disease has been of fairly long standing duration.

It must be remembered that this disease, or one very closely allied to it, will attack cattle and goats as well as sheep. The symptoms in these animals are similar. The treatment used in the previous cases, viz.: 2 per cent. solution of zinc sulphate, or 2 per cent. of silver nitrate, in water, is equally effective in other animals, the silver nitrate treatment being probably somewhat more efficient, although liable to deterioration, particularly in the presence of light. To prevent the spread of the disease to other animals, the segregation of the affected ones should be carried out immediately the disease is detected, and the prescribed treatment started as soon as possible.

A NOTE ON FOWL POX.

By Chas. R. Turbet, B.V.Sc., Senior Government Veterinary Officer.

Many people consider that the disease of chickens often seen in the vicinity of Suva and elsewhere in Fiji, and known as chicken-pox or contagious epithelioma is the direct result of the irritation caused by mosquito bites. This, however, is not so, the disease being one which is caused by the infection with the virus of chicken-pox, similar in character to that of human pox or cow-pox.

It has now been recorded by Kligler, Muckenfuss and Rivers ("Transmission of Fowl Pox by Mosquitoes") *The Journal of Experimental Medicine*, Vol. XLIX, No. 4, page 649, that fowl pox can be definitely transmitted from infected to non-infected non-immune birds by the bites of mosquitoes which have previously fed on infected birds.

The authors of the above mentioned Article record a number of experiments in which two different varieties of mosquitoes were first allowed to feed on the combs of infected chickens and then again upon healthy birds.

It was shown that both *Culex* and *Aedes* mosquitoes are capable of transmitting the disease from one bird to another. It was also found that the mosquitoes remain capable of carrying infection for at least 14 days following a meal on a diseased fowl, and this must therefore be taken into consideration in any scheme for the control of the disease.

It is now considered that immunisation of chicken offers the best method of controlling losses. Combined with that, however, general mosquito control should be undertaken by the community, whilst, where possible, chickens should be housed by night in mosquito proof houses. Curative treatment consists of supplying water containing potassium iodide, plucking the nodules and painting the affected area with a mixture of equal parts of tincture of iodine, Friar's balsam and glycerin.

Owners should get into touch with the Veterinary Division of the Department of Agriculture whenever an outbreak occurs in their poultry run.

KAPOK.

(Reprinted from the *Bulletin of the Imperial Institute*, Vol. XXIV, No. 1, 1926.

A Survey of its Production within the Empire, with Notes on its Cultivation and Uses.

The fine, cotton-like fibre known as kapok is now familiar to everyone from its widespread use as a stuffing material in upholstery. The tree which produces it occurs in all the tropical parts of the British Empire, but practically the entire commercial supply of the fibre is obtained from Java. Efforts have been made at different times to start an export trade in kapok from various British countries, but hitherto the only success obtained, and that on a relatively small scale, has been in Ceylon. The Agricultural Department in Malaya has recently taken up the matter energetically, and there seems every reason to expect that commercial supplies will eventually become available from that country. India exports a certain amount of floss under the name kapok, but this, as will be shown later, is principally derived from a different tree from that furnishing Java kapok and is inferior to the latter in quality. Among foreign countries, other than Java, there is a small export of true kapok from the Philippines and Indo-China. In these countries, and also in Siam, the extended cultivation of the tree is being advocated. A certain amount of floss, of diverse origin, is also shipped from South America.

In view of the interest at present being shown in the material, it has been considered opportune to publish the present article dealing with the prospects of kapok production within the Empire, whilst for the benefit of those desiring to grow the tree for the production of the fibre, information has been given as to methods of cultivation and preparation. Specimens of kapok produced in many countries of the Empire may be inspected at the Imperial Institute by those interested.

As indicating the existing demand for kapok, it may be mentioned that in 1924 Java and Madura exported over 15,000 tons, of a total value exceeding 1½ million pounds sterling. Of this quantity nearly 8,000 tons was shipped to the United States; the Netherlands and Australia each took about 3,000 tons and New Zealand and the United Kingdom 500 and 400 tons respectively. There was also in that year an export of a about 1,000 tons from the Outer Possessions of the Dutch East Indies, the bulk of which was consigned to the Netherlands. The imports of kapok into the United Kingdom during recent years are shown in the following table:—

From	1922.		1923.		1924.	
	Tons.	£	Tons.	£	Tons.	£
India	355	24,578	566	52,486	333	31,783
Other British Possessions	103	7,544	95	10,521	108	9,174
Netherlands	78	7,911	30	3,421	53	7,173
Java	362	36,826	558	69,608	358	44,235
Indo-China	..	32	..	....	113	12,616
Other Foreign Countries	5	470	90	4,697	36	2,617
Total Imports	903	77,361	1,339	140,733	1,001	107,598
Total retained in the United Kingdom	711	58,954	1,113	115,839	690	74,505

The quantities of Indian kapok retained in this country during the three years were 256, 449 and 250 tons respectively. The corresponding figures for Java kapok were 302, 473 and 288 tons.

In considering the question of extending the production of kapok within the Empire, it is important to bear in mind the possible effect on prices of a large increase in the supplies. In this connection the Imperial Institute is informed by a large firm of kapok merchants that the demand for kapok is increasing, especially in the United States and in certain of the British Dominions, and is likely to continue to do so. They consider that it would be desirable to further the production of the floss within the Empire. Similar views were expressed by an important firm of kapok brokers. As regards the United States it has been stated that mattress manufacturers in that country cannot " boom " kapok, owing to the difficulty of obtaining supplies. On the whole, therefore, it seems probable that, provided properly prepared material equal to or approaching the Java product in quality can be supplied within the Empire, there should be no difficulty in finding a market for it at good prices.

Before the war the market price of Java kapok in London was about 7d. to 9d. per lb. Towards the close of the war the price had risen to as much as 1s. 9d. It has since fallen somewhat and prime Java kapok is now quoted at 1s. 3½d. per lb.

Sources and Uses of Kapok.

In a large number of plants belonging to widely different families the ripe fruits contain a mass of fine hairs, sometimes attached to the seeds, as in the case of cotton, or arising from the wall of the capsule, as in kapok. These hairs are intended by nature to aid in the distribution of the seeds, but man has adopted them in some cases for his own use. In the most notable of these, cotton, it has been possible by hybridisation, selection and suitable cultivation to produce material which in length, colour, yield and other properties shows a vast improvement over the wild forms. The group of fibres to which kapok belongs, known collectively as flosses or silk-cottons, are usually finer than cotton and exhibit a greater lustre, but they are much weaker than cotton and lack the twist which enables the latter to be spun. Their use, therefore, has hitherto been restricted, and apart from the careful cultivation and preparation of true kapok little has been done to improve their quality.

The term " kapok " has been used for the product of a number of trees, but it should be restricted to the floss of *Eriodendron anfractuosum* (= *E. orientale*, *Ceiba pentandra*), the source of Java kapok. This tree, which belongs to the natural order Bombacaceæ, reaches a great size under natural conditions, but in cultivation is usually seen as a slender tree not exceeding 50 ft. in height. It has a very characteristic appearance, producing horizontal branches arranged in tiers. It sheds its leaves in the dry season; the flowers appear just before or at the same time as the new leaves. The fruit is a more or less oblong capsule or pod, about 6 in. long and 2 in. in diameter at its greatest width. As already mentioned the hairs spring from the inner wall of the capsule and are not attached to the seed itself, as in the case of cotton. This is of some importance in connection with the commercial preparation of the floss, as it renders the separation of the seed much more easy, the hairs not having to be forcibly removed from the seed as is necessary in the ginning of cotton.

Flosses allied to true kapok are yielded by many other plants of the Bombacaceæ, the chief of which are species of *Bombax*. The floss exported from India is mainly derived from *B. malabaricum*, and this, when properly prepared, is of good quality, but is not so resilient as good Java kapok. Several species of the genus occur in West Africa, where their floss is used locally, the chief of these, perhaps, being *B. buonopozense*. Other members of the family yielding flosses include *B. Ceiba* and *Chorisia* spp. of South America, *Eriodendron samauma* of Brazil and *Ochroma lagopus* of tropical America and the West Indies. Amongst other plants producing silk cottons may be mentioned species of *Asclepias*, *Calotropis gigantea*, *C. procera* and *Gomphocarpus brasiliensis* belonging to the Asclepiadaceæ, *Cochlospermum gossypium* (Bixaceæ) and the West African rubber tree, *Funtumia elastica* (Apocynaceæ). All these flosses are inferior to true kapok and are unlikely to compete with it in European markets.

The hairs of kapok are cylindrical, from 0·6 to 1·2 in. in length, with very thin cell walls. The cells are full of air and are very light; they also possess the property of being impermeable to moisture, and on this account are extremely buoyant. For this reason kapok is now used throughout the world for the manufacture of buoys, life-belts and life-saving jackets.

The chief use for kapok is for stuffing cushions, pillows, matresses and similar articles. It is well adapted for this purpose on account of its lightness, its springy or resilient nature and its non-hygroscopic and non-absorbent characters. It is in their resiliency that most other flosses are inferior to kapok and therefore of less value for stuffing purposes.

Many attempts have been made to employ kapok as a textile material, but considerable difficulty has been experienced due chiefly to the fact that the fibres have a smooth, slippery surface and, therefore, lack cohesive force. Moreover, kapok is very weak, and yarns made from it are not strong enough for use where any strain is likely to occur. It is stated that the difficulty of spinning the fibre has been surmounted by roughening the surface by chemical treatment, and so enabling it to exert the necessary grip. By a special arrangement and adaptation of the spinning machinery the roughened fibres can be spun either alone or in admixture with cotton. The yarns so produced are said to be suitable for the manufacture of plushes, lace and other materials. Kapok textiles cannot possess such good wearing properties as those made of cotton, but owing to their non-conducting character they might find a special use as an interlining in warm clothing.

Kapok Seed.

In the course of preparing kapok for the market large quantities of seed are obtained. The seed is rich in oil, and in many countries where the floss is prepared for local use the oil is expressed from the seeds and employed for cooking and other purposes. In the Dutch East Indies the seed now forms an important source of revenue; in 1924 about 14,000 tons, valued at £97,500 were exported from Java and Madura, of which all but 1,000 tons were consigned to the United Kingdom.

Samples of kapok seed from Travancore, the Federated Malay States, Gold Coast and Zanzibar have been examined at the Imperial Institute. The results are shown in the following table, which includes for comparison the figures for Java kapok seed and oil and for cotton seed and oil.

It will be seen that in general characters the oil resembles cotton-seed oil. After refining it can be employed as an edible oil, and it is also suitable for soap-making and other purposes to which cotton-seed oil is applied. There

	Kapok Seed and Oil.						*Cotton Seed and Oil.*
	Travancore.	Federated Malay States.		Gold Coast.	Zanzibar.	Usual Range.	Usual Range.
		I.	II.				
Seed.							
Moisture, per cent ..	11·4	13·8	12·9	13·2	12·7	...	...
Yield of oil, per cent.	24·3	20·0	18·8	24·7	21·0	22–25	20–24
Yield of oil (moisture free seeds) p. c. ..	27·4	23·2	21·6	28·4	24·0	...	...
Oil.							
Specific gravity at 15°/15° C.	0·9217	..	..	0·9226	0·914	0·921–0·933	0·922–0·925
Acid value	30·9	54·1	61·0	6·1	26·0	variable	variable
Saponification value	192·2	..	..	193·5	194·2	189–195	192–195
Iodine value (Hubl, 17 hours) per cent.	90·4	..	..	89·6	101·5	85–94	105–115
Unsaponifiable matter, per cent.	1·2	..	..	..	..	...	0·8–1·8
Refractive index at 40° C.....	1·463	..	..	..	..	1·4605–1·4657	1·4646–1·4653
Solidifying point of fatty acids	29·8° C.	..	..	..	..	27–32° C.	33–37° C.

is a steady market in the United Kingdom for kapok seed, and a small consignment received at the Imperial Institute from the Federated Malay States was sold in Liverpool in March 1925 at the rate ruling for Java kapok seed, viz., £11 15s. per ton, c.i.f. As regards the marketing of the seed the Institute is informed that it is the custom in this country to allow 25 per cent. of damaged seed in a consignment without any reduction being made in the price, notwithstanding the fact that the seed obtained from kapok plantations in Java contains, as a rule, only a little over 4 per cent. of defective seed.

The residual cake, left after the expression of the oil, forms a fairly good feeding-stuff for live-stock; it is somewhat inferior to cotton-seed cake, and is believed to be used principally as an ingredient in compound feeding-cakes. The composition of the meal obtained from Travancore seed at the Imperial Institute is shown in the following table, in comparison with commercial kapok-seed and undecorticated cotton-seed cake.

	Kapok meal from Travancore seed.		Commercial kapok-seed cake.*	Undecorticated cotton-seed cake English make.*
	As prepared at the Imperial Institute.	Calculated to contain 7 per cent. of fat.		
	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	33·8	12·9	13·8	13·8
Crude proteins	32·7	30·6	26·2	24·6
Fat.....	0·5	7·0	7·5	6·5
Carbohydrates, &c., (by difference).....	19·8	18·4	23·2	29·3
Crude fibre	26·8	25·1	23·2	21·2
Ash	6·4	6·0	6·1	4·6
Nutrient ratio	1:0·6	1:1·1	1:1·5	1:1·67
Food units	103	112	107	107

* Smetham, *Journ. Roy. Lancs. Agric. Soc.*, 1914.

The cake is rich in constituents of manurial value, the percentage (expressed on dry matter) in the case of cake prepared in Indo-China being as follows:

Nitrogen	4·5
Phosphoric Acid (P_2O_5)	1·6
Potash (K_2O)	1·5

Indian kapok seed (*Bombax malabaricum*) yields an oil similar to that obtained from true kapok seed, but of slightly better quality (see this Bulletin, 1920, 18, 335). The residual cake is rich in proteins and would form a more valuable feeding-stuff than kapok seed cake.

Other By-products.

The wood of the true kapok tree is light and soft and little used, even by the natives. It has been suggested that the wood might be suitable for paper-making, but experiments conducted some years ago by a firm of paper manufacturers in this country were not very satisfactory, and it was not considered that the production of pulp from the material would be a commercial success. More recent experiments in France showed that the wood yields 30 per cent. of bleached pulp (expressed on the dry material), which furnishes a paper of ordinary quality.

The young leaves and the roots are used in native medicine, whilst the bark contains a reddish-coloured fibre sometimes used by the natives for tying purposes.

Production of Kapok in the Empire.

Asia.

True kapok grows in the hot moist tracts of Western and South India and in Burma, but it is nowhere systematically planted. The internal trade in the floss is stated to have developed considerably, but the quantity shipped is small, most of the so-called kapok exported from India consisting as already mentioned, principally of the floss of *Bombax malabaricum*. So far as can be judged from material examined at the Imperial Institute, the true kapok produced in India is of good quality. A sample from Madras examined in 1906 was considered by brokers to be fully equal to good Java kapok and a sample from Travancore recently received at the Institute was also favourably reported on.

The exports of Indian kapok, chiefly from Bengal and Bombay, in 1923-4 amounted to 1,692 tons, of total value of £136,000. Of this quantity 448 tons were shipped to the United Kingdom, 272 tons to the Netherlands, 210 tons to Germany, 196 tons to France, 140 tons to Italy, 110 tons to the United States and 73 tons to Australia.

Two grades of Indian kapok are recognised on the London market, viz., Calcutta and Bombay. Double-cleaned Calcutta kapok was recently quoted at 1s. to 1s. 0½d. per lb, or 3d. less than prime Java.

Eriodendron is a common tree in Ceylon and is widely distributed. It grows from sea-level to 2,500 ft. or more, but gives the best results at low and intermedate elevations. It is planted in village gardens and on some estates as a boundary tree. There is a small export of kapok from the island, the quantity in recent years amounting to about 300 tons, most of which has been consigned to the Netherlands. The quality is usually intermediate between Indian and Java kapok.

In parts of Malaya the kapok tree is grown in considerable numbers by the peasants, but hitherto little use has been made of the product except for domestic purposes. The Agricultural Department have recently made

an exhaustive study of the possibility of establishing an export trade and have initiated a scheme for collecting the pods from existing trees and selling the floss and seed. Further, they definitely assert that Malaya is suitable for the profitable production of kapok under plantation conditions.

It is estimated that at the present time there are about 100,000 trees in Malaya, of which 7,500 are in Selangor (mainly in Kuala Selengor); 3,800 are scattered in Pahang; 62,000 are in Perak (of which 40,000 are near Perak River and 20,000 in Krian); 7,000 are scattered in Malacca; and 6,100 are in Penang (4,000 of which are in Balik Pulau). Of the trees now now in bearing nearly three-quarters are to be found in the four definite workable areas mentioned in brackets above. It is in these districts that endeavours will be made to teach the Malays to harvest the pods and prepare the floss for the market. Collecting centres will be established at which kapok brought in by the natives will be purchased for cash. In certain districts arrangements have already been made, under European management, for the purchase of kapok and its preparation for the market.

Kapok of fairly good quality has been produced in Mauritius, but, owing to the ravages of a beetle, the cultivation of the tree had to be given up (see page 60). A sample of floss from trees grown at the Botanic Gardens, Pamplemousses, was examined at the Imperial Institute in 1906. It was slightly darker than ordinary Java kapok, more uneven in colour and somewhat inferior in lustre. Similar material would find a market in this country at prices a little below that of the Java product.

Africa.

The kapok tree reaches a very large size in the West African forests, being only exceeded by a few mahoganies. It occurs in all the British Colones of West Africa and is found in both the evergreen and mixed deciduous forests. No systematic attempt seems to have been made to collect the floss, except in Togoland, Here kapok received special attention under the German régime and seed was distributed in large quantities to the natives. The tree occurs throughout the whole of the Mangu-Jendi District in Northern Togoland, part of which is now included within the British sphere, but it is considered that the establishment of any extensive export trade from this district would have to await the provision of railway transport. Before the war there was a small export from Togoland, 9 tons being shipped in 1913. This is stated to have been derived mainly from wild trees. A small bale of kapok from Togoland was received at the Imperial Institute from the Chief Commissioner, Northern Territories, Gold Coast, in 1916. It was similar in all respects to the kapok of commerce and was sold at a satisfactory price, considering the small quantity available. It would certainly be worth while to encourage the natives to collect and clean the material for export, both in this district and in other parts of British West Africa. It will be necessary, however, to insist on the systematic picking of the pods in order to maintain the quality of the floss, and not to allow the natives merely to gather the fallen pods, as they at present do for their own use. The results of examination of material received in recent years at the Institute from the Gold Coast and Gambia indicate that kapok of good quality could be produced in those countries if due care were taken in the preparation.

In East Africa the systematic cultivation of kapok has been undertaken in Tanganyika. Before the war the industry was increasing, the area under cultivation in 1910, 1911 and 1912 being 1,735, 3,458 and 6,580 acres res-

pectively, and the exports in those years being 12, 28 and 52 tons. No information appears to be available as to the present area under kapok in the Territory, but it has been stated that the plantations suffered damage by elephants, both during and since the war. There are signs, however, that the industry is reviving, and during the four years ending 1924, quantities of 6, 30, 32 and 52 tons respectively were exported. The local Department of Agriculture do not seem to favour any extension of the cultivation, as the kapok trees are liable to harbour insect pests which may spread to the cotton-fields.

Kapok is stated to grow well in the coastal region of Kenya, and it is planted commonly as a boundary tree in Zanzibar. Floss produced in Government plantations in the latter country is stated to have been exported to the United Kingdom.

The tree thrives well in the Sudan, and floss obtained from trees planted at Mongalla was examined at the Imperial Institute in 1917. It proved to be of excellent quality, and similar material, if produced in commercial quantity, should realise the market price of good Java kapok.

West Indies.

The kapok tree is found in most of the West Indian islands; one, at Nassau, Bahamas, has reached a very large size and is familiar to all visitors to that island. There seems little hope, however, of the floss from existing trees in the West Indies being collected for export, owing to their very scattered distribution. Moreover, it is unlikely that the tree will be planted specially for the production of floss, on account of its harbouring a cotton stainer; indeed, for this reason it has been made compulsory in St. Vincent that all kapok trees should be destroyed.

An attempt was made some years ago to introduce the cultivation of the tree into British Guiana, and a number of plants were raised for distribution but no development appears to have been recorded.

Australasia.

The tropical parts of Australia seem suitable for the cultivation of kapok, and a few trees already exist round some of the towns in Northern Queensland. The Agricultural Department in Queensland have drawn attention to the possibility of producing the floss for the Australian market, at present supplied by Java, and point out that the tree can be grown practically along the whole of the Queensland coastal belt from Brisbane northwards. They suggest that the most profitable method in that area would probably be to plant the trees as wind-breaks or shade trees, rather than in the form of pure plantations.

In New Guinea, under the German régime, kapok trees were regularly planted for several years and the crop was collected and exported. The produce was of good quality and realised satisfactory prices, but the cultivation was stated to be unprofitable, chiefly on account of the high cost of transport, and was, therefore, abandoned.

The kapok tree is cultivated by natives in all parts of North Borneo, but the industry has made little progress, as the floss has mostly been shipped in the uncleaned state. The cleaned floss, however, is of excellent quality, and has been sold in the London market at the price of the best Java kapok. In 1919 a concession was granted to a London company giving them the sole right to export kapok from the territory, and in return they agreed to purchase at a fixed minimum price all kapok offered to them. The com-

pany also undertook to install cleaning machinery and to export a minimum quantity of cleaned floss per annum. In the event of the supply of kapok being insufficient the company will themselves undertake planting operations. During the first year (up to July, 1920), the company had purchased from producers 38 tons of kapok, most of which was shipped to London, and small quantities have continued to be exported each year since.

Attention is also being devoted to kapok in Samoa. The tree grows practically wild throughout the islands, and is at present chiefly used as a wind-break in cocoa plantations.

Cultivation.

Climate.

A suitable climate is the first essential to the successful cultivation of the kapok tree. Although found in a wild or semi-wild state from the sea-level up to an altitude of 3,000 or even 4,000 ft. and more, the tree gives the best yield and quality of fibre when grown at elevations less than 1,500 ft. above the sea. It will withstand slight frost, but low temperatures hinder the growth of the tree and the development of the fibre, and from a commercial point of view cultivation should be attempted only in the tropics or in certain parts of semi-tropical countries. As regards rainfall, the tree flourishes under a wide range of conditions. It reaches its greatest size in the tropical rain forests of West Africa, but at the same time owing to its deciduous habit, it can resist long periods of drought. The ideal conditions are abundant rain during the growing season and a dry period from the time the flowers are setting until the pods are harvested. As in the case of cotton, a long spell of wet or even damp weather during the later stages of pod formation will greatly reduce the quality of the fibre.

The quick growing branches are easily broken or damaged by high winds, and exposed situations should therefore be avoided in fixing the site of plantations.

Soil.

A well-drained soil is necessary for the proper growth of kapok. It flourishes well on a deep, porous, sandy loam, such as is frequently found on alluvial flats along streams, but the finest kinds of Java kapok are produced on well-weathered volcanic soil. It is not always advisable to plant the better land exclusively with kapok, since this can often be more profitably used for other crops. Nevertheless, a soil of fairly high fertility is required since the returns from kapok are relatively low, and a high yield is therefore essential.

Land infested with white ants should not be used for kapok since the tree is very susceptible to the attack of these insects.

Propagation.

The tree is easily propagated from either seed or cuttings. The merits of the two methods have been a matter of dispute. Plants raised from cuttings come into bearing somewhat earlier, but, on the whole, the general opinion is in favour of propagation by seed. Advantages of the latter method are that a deep-growing tap-root develops which renders the plant less liable to be uprooted by high winds, and the plants remain longer in bearing. Where a form notable for its high yield or other specially favourable character is to be reproduced, cuttings should be employed.

Seed for sowing should, whenever possible, be specially obtained from the largest pods of old high-yielding trees, instead of using purchased seed

of unknown parentage produced in the course of cleaning the floss. About 6 lb of seed should be sufficient for planting up 100 acres. The seed is sown in nurseries, sometimes in rows 10 to 12 in. apart in raised beds, or, as recommended in the Philippines, in "hills" about 6 in. apart. The nursery must be carefully prepared, the soil manured beforehand, if poor, and kept well weeded. In dry weather watering may be necessary. As soon as the seed has germinated, which takes only a few days, the seedlings are shaded until they are about 5 or 6 in. high, when they must be exposed to the sun. If the plants do not obtain plenty of sunshine they grow thin and lanky. At this stage the seedlings should be thinned out to 6 or 9 in. apart; when sown in hills only one seedling should be allowed to each hill. The young plants grow very quickly, and when from 6 to 12 months old they should be planted in their permanent quarters.

Owing to the readiness with which kapok cuttings take root, this method of propagation has hitherto been that most commonly used by the natives of Ceylon and the Philippines. The cutting, which should never be of the current year's growth, varies in size from about $\frac{3}{4}$ to 2 in. or more in diameter and from 18 in. to 6 ft. or more in length. Experiments conducted in the Philippines with cuttings ranging in length from 1 to 10 ft. and $\frac{1}{2}$ to 5 in. in diameter at the base, showed that the larger cuttings gave the best results, 100 per cent. of those 6 ft. or more in length and $3\frac{1}{2}$ in. or more in diameter striking root, as against from 15 to 70 per cent. in the case of the smaller cuttings. The cuttings should be inserted as soon as they are cut, about 12 to 18 in. deep according to their size, and this work should be done, if possible, at the beginning of the rainy season. The cuttings must be inserted in the place they are to occupy permanently.

Planting Out and After-cultivation.

In Java, and indeed in most countries where the natives cultivate kapok, the trees are most commonly planted irregularly, as boundary trees and fences, along the sides of roads, or with other trees in the gardens. It is from such indiscriminately planted trees that most of the kapok produced is still obtained. In Java the tree is sometimes planted between other crops, such as coffee, cocoa, pepper and vanilla, whilst in the Philippines it has been suggested that fibre crops like maguey, sisal and mauritius hemp, might be interplanted with kapok. The most suitable crop to be grown in this way will vary with local conditions, and from observations made in Malaya it is thought that roselle fibre, sunn hemp, tuba, limes and tobacco should prove successful. In quite recent years the practice has been commenced in Java and the Philippines of growing kapok as the sole plantation crop; but this method will probably only give profitable results where the conditions are specially favourable to the production of high yields.

When grown as the only crop in plantations the seedlings or cuttings should be placed about 18 ft. apart, but in mixed plantations the distance will vary with the nature of the accompanying crops. The seedlings, when removed from the nursery, should be topped and all leaves removed. In lifting the plants, the roots must be damaged as little as possible, and planting out should be done immediately. If possible, transplanting should be performed during showery weather.

Little cultivation of the soil is required in kapok plantations. For a few months after planting the soil should be kept loose round the plants, and if kapok is the sole crop it is only necessary to keep the ground clean for a short distance from the tree to facilitate the collection of the pods. The remainder of the plantation is preferably planted with a leguminous cover crop, so that the cost of weeding is reduced to a minimum.

Harvesting and Yield.

Where, as in Java, the pods ripen during a dry season, they are often collected each day as they fall to the ground, but if rains are liable to occur during the harvesting period, the pods must be picked from the tree as they mature; otherwise the floss may suffer considerable damage. As the pods ripen their colour changes from a light green to a light brown and the surface, at first smooth, becomes somewhat wrinkled. It is at this stage, and before the pods open at the end, that they should be picked. It is no economy to harvest the whole crop at once, since this will result in a mixture of unripe, ripe and over-ripe pods, which will give a product of low value. The ease with which the branches break precludes the gathering of the pods from tall trees by climbing, and they are best gathered by means of knives or small hooks attached to long poles. The harvesting season usually extends over a period of about 3 months. The pods must be spread out on a dry floor in the sun to ripen thoroughly and the floss removed as soon as possible. If it is necessary to store the pods for a time, they must be thoroughly dried, so as to avoid fermentation and discolouration of the floss.

Kapok trees usually begin to bear after 3 or 4 years, but the yield at first is small. Seven-year old trees will yield 350 to 400 pods, and 10-year old trees 600 pods or more. The yield of cleaned floss from the pods varies somewhat, but on the average it may be taken that 100 pods furnish 1 lb of cleaned floss. On this basis an acre planted with 132 trees (18 × 18 ft.) would yield about 800 lb of floss.

Preparation of the Fibre.

Although machinery is now largely employed for cleaning kapok in Java, the initial process of opening the pods and removing the floss and seeds from the husk and core is always done by hand, chiefly by women and children. The subsequent separation of the floss from the seed is the most important process in its preparation. A common native method is to place a quantity of floss and seeds on a perforated platform and beat it with bamboo sticks, wielded in a horizontal direction, so that the seeds are loosened and fall through the holes in the platform. This is continued until the floss is beaten up into a snow-like mass. The top layer is then removed and given a further beating on another platform, when the floss is ready for baling. In an improved method, which has come into use in Java, the floss as it comes from the pods is placed in a bamboo basket or hollow cylinder with a perforated base, and the mass stirred up by a paddle-like arrangement revolved within it by means of a handle. These hand methods are only of use where kapok is produced on a comparatively small scale. On a large scale machine-cleaning is essential. Most of the machines hitherto employed consist of a horizontal chamber with a perforated bottom, in which the floss is beaten up by a series of blades revolving close to fixed blades on the sides of the chamber. The blades are so arranged that the floss moves along to the end of the chamber, where it is either blown out by fans or falls into receptacles. The Bley machine, invented by a Java planter, is claimed to be able to clean 217 kilos. of floss per hour. This could only be used profitably on a very large scale. A smaller machine, of British manufacture, capable of cleaning 120 to 130 kilos. of floss per day of 10 hours, has been used in the Philippines.

Kapok should always be graded carefully before baling for export. As a rule, four grades of cleaned Java kapok are recognised: (1) Superior or extra, containing less than 0·5 per cent. of seed; (2) prime, containing not more than 2 per cent. of seed; (3) fair average, with no more than 3 ½ per cent. of seed; and (4) damaged.

Owing to the bulky nature of the material, the floss is pressed into bales for export. The pressure applied will depend on the size of the bale, but too much must be avoided, particularly with the finest quality, otherwise the elasticity of the fibre will be destroyed. Machine-cleaned, very dry fibre requires more pressure than hand-cleaned, but on the average the pressure should not exceed 140 lb per sq. in. Thus a bale 2 ft. wide by 2 ft. long will require a pressure of 80,640 lb. The bales are generally packed in gunny cloth or matting and are bound with galvanised iron hoops, cane, or fibre. The weight of the Java bales ranges from 80 to 120 lb and the size from 8 to 16 cubic ft.

Pests and Diseases.

So far few insect pests and fungoid diseases have been recorded as causing any great damage to the kapok tree or floss. This may be due to the custom, most frequently followed at present, of growing the tree in isolated positions. If large plantations are made it will be necessary to keep careful observation to prevent the spread of harmful insects and diseases, just as is the case with other plantation crops.

In Malaya and certain other countries white ants are the most serious pests, especially to young plants, and the usual precautions against these insects must be taken. An insect (*Dysdercus cingulatus*), allied to the cotton stainer, sometimes attacks the pods, but the damage is said to be slight. A related species has also been reported on kapok in San Thomé. It is sometimes considered inadvisable to grow kapok in the vicinity of cotton, owing to the danger of stainers spreading to the latter crop and, as already stated, in St. Vincent all kapok trees have to be destroyed. There is little risk, however, if the trees are properly tended and care is taken not to allow old pods to lie on the ground. In the Belgian Congo, kapok trees in the neighbourhood of cocoa plantations are cut down, owing to the fact that they serve as host-plants for a serious cocoa pest, *Sahlbergella singularis*. Caterpillars of several kinds of moths do a certain amount of damage, and one of them (*Mudaria variabilis*) in certain years has been known to destroy a large proportion of the crop in Java. In 1914, for example, it is recorded that 30 per cent. of the pods were attacked. The caterpillar feeds on the undeveloped fibre and seeds of the green pods, and even if any fibre should mature it is usually badly stained, whilst birds in their search for the caterpillars often complete the destruction of the pods. Other caterpillars bore into the stem and twigs, and some feed on the leaves. Boring beetles of the genus *Batocera* also attack the tree, and one of them (*B. rubra*) is so partial to it in Mauritius that kapok cultivation has had to be given up in that island.

Bats, monkeys and squirrels sometimes do considerable damage by eating the green pods or growing shoots.

Among the worst enemies of kapok in Java and Malaya are parasitic flowering plants of the genus *Loranthus*, which send out suckers into the bast and wood of the tree and absorb the nutriment required by the growing shoot. In bad cases the whole tree becomes weakened by the loss of the necessary nourishment and great damage may thus be caused. The trouble is not difficult to control if the plantation is properly inspected at regular intervals and all parasites removed as soon as they make their appearance.

Among the few fungoid pests of kapok, pink disease (*Corticium salmonicolor*) has been known to attack the plant, and leaf spot (*Ramularia eriodendri*) and an unidentified disease causing bleeding at the base of the trunk have occasionally been reported.

BIBLIOGRAPHY.

The following list includes the most important publications dealing with kapok issued in recent years. Most of them may be consulted in the library of the Imperial Institute, where further information is available regarding the various points dealt with in this article. Those marked with an asterisk have been largely consulted in compiling the notes on cultivation.

Bley, G. F. J.,: "De Kapokcultuur op Java." (Soerabaia, 1911.)
Crevost, C. and Lemarié, C.: "Plantes et Profuits Filamenteux et Textiles de l'Indochine. Ouatiers." *Bull. Econ. Indochine* (1919, 22, No. 137, pp. 553–591).
*Grist, D. H:: "Kapok." *Malayan Agric. Journ.* (1923, 11, 3–27).
Houard, A.: "L'Exploitation du Kapok en Afrique occidentale francaise," in Henry's "Matieres Premieres Africaines," Tome I, pp. 154.218. (Paris, 1918.)
*Mathieu, E.: "Kapok." A Lecture given at Kuala Kangsar, Aug. 16, 1922. (Singapore, 1922.)
*Saleeby, M. M.: "The Kapok Industry." *Bull.* No. 26 (revised ed.), *Philippine Bur. Agric.* (Manila, 1925.)
Schaefer, H.: "Die Produktion von Kapok und dessen Stellung in der Weltwirtschaft." *Beiheft sum Tropenpflanzer* (1925, 22, No. 1, pp. 1–54).
Zimmemann, A.: "Der Kapokbaum (*Ceiba pentandra*)." *Der Pflanzer* (1914, 10, 123–133).
Warburg, O.: "Baumwolle-Ersatzstoffe." *Verhandlungen der Baumwolle-Kommission der Kol. Wirt. Kom.* (1911, No. 2, pp. 62–80).

Note by Editor.

For some further information on this subject we are indebted to Messrs. Burns Philp & Co. Ltd., through the courtesy of their Levuka Manager.

They inform us that seed selection in Java has been brought to a high pitch and such selected seeds are expensive, costing about £10 per cattie = 1½ lb English. Unselected seeds are crushed for oil and fetch from £5 to £8 per ton.

The bulk of the output in Java is still native grown but there are also a number of European owned estates.

The Editor would suggest that intending European planters should go carefully into the labour costs in Fiji. Labour in Java seldom costs more than 1s. per day and most of the sorting and separating the floss from the seed is done by women. (The Editor was informed when in Java that women earned about 9d. per day.) Machinery can be employed for part of this work and, under the much more expensive labour conditions in Fiji, would have to be used. It is also required for pressing the bales. It would be necessary to ascertain—

(1) cost of this machinery;
(2) necessary output to make machinery an economic proposition;
(3) proportion of work of preparation which cannot be done by machinery and relative cost thereof.

SOME USEFUL FORMULAS.

No. 1.—Lead Arsenate.

Stomach poison for biting insects on plants.

Lead arsenate paste 2 to 3 lb to about 50 gallons of water.

No. 2.—American-Argentine Ant Syrup.

Granulated sugar	12 lb
Water	11 parts.
Crystalised tartaric acid	7 grams.
Benzoate of soda	9 grams.

Boil slowly for half an hour; allow to cool.

Dissolve sodium arsenite (C.P.) ¾ oz. in ½ pint of hot water. Cool, and add poison solution to syrup and stir well. Then add to the poisoned syrup 2 lb of strained honey and mix thoroughly.

No. 3.—Bordeaux Mixture.

(Average strength.)

For fungus diseases of plants.

Bluestone	16 lb
Quicklime	20 lb
Water	200 gallons.

Dissolve the bluestone and slake the lime in separate vats, the bluestone to be kept from contact with all metals except copper. Thoroughly mix the dissolved bluestone with one-half the water and the slaked lime with the other half. Run the two mixtures together in a single stream into the spray tank through a fine screen. For convenience, the mixing vats may be placed on an elevated platform, and the two parts mixed as they are flowing into the spray tank. The milk of lime should be continuously stirred during the mixing.

A somewhat less satisfactory Bordeaux mixture may be made as follows:—Slake the lime and dissolve the bluestone in separate barrels as above. Fill the spray tank half full of water; add the dissolved bluestone; strain in the slaked lime while the agitator is running; add remainder of water, and mix thoroughly.

No. 4.—Kerosene Emulsion.

Contact poison for sucking insects on plants.

This is one of the most useful of all the contact insecticides for spraying plants against scale insects, mealy-bug and all related insects. The difficulty of getting a true emulsion with the water which is available in many localities has proved an objection to its use, but with care and by the use of rain-water, an emulsion ought to be obtained.

Kerosene emulsion is made from—

Hard soap	½ lb
Kerosene	2 gall.

Dissolve the soap in 1 gallon of water by boiling. Remove from the fire and immediately add 2 gallons of kerosene and churn violently with a syringe or force pump until the mixture becomes creamy, and the oil is all held by the soap. This is the stock solution, and is sufficient for 33 gallons of wash. Great care should be taken to get a perfect emulsion as any free oil is likely to injure the plants. If any considerable layer of oil is observed on the surface of the stock solution when it has stood for 24 hours or more, the emulsion is not perfect. If difficulty is experienced in this respect, an increase of the amount of soap will often aid in producing the emulsion.

The above formulas Nos. 1, 2 and 3 are from Circular No. 265, College of Agriculture, University of California.

No. 4 is from *Insect Pests of the lesser Antilles*, by H. A. Ballou.

CONTENTS.

PAGE

EDITORIAL 41

THE DRYING OF COPRA *by F. A. Stockdale* 41

THE NATURAL CONTROL OF THE COCONUT SCALE *by T. H. C. Taylor* 43

INTRODUCTION OF NATURAL ENEMIES AGAINST THE HOUSE FLY IN FIJI *by H. W. Simmonds, F.E.S.* 46

EXPERIMENTS WITH HOUSE FLIES IN FIJI *by H. W. Simmonds, F.E.S.* 46

CONTAGIOUS OPTHALMIA IN SHEEP *by H. M. Stuchbery, B.V.Sc.* .. 47

A NOTE ON FOWL-POX *by Chas. R. Turbet, B.V.Sc.* 49

KAPOK 50

SOME USEFUL FORMULAS 61